

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 2. REPORT TYPE Technical Papers 3. DATES COVERED (From - To)

4. TITLE AND SUBTITLE 5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S) Please see attached 5d. PROJECT NUMBER 2302 5e. TASK NUMBER M1G2 5f. WORK UNIT NUMBER 346120

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Research Laboratory (AFMC) AFRL/PRS 5 Pollux Drive Edwards AFB CA 93524-7048 8. PERFORMING ORGANIZATION REPORT

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory (AFMC) AFRL/PRS 5 Pollux Drive Edwards AFB CA 93524-7048 10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S NUMBER(S) Please see attached

12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT 20030129 193

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF: 17. LIMITATION OF ABSTRACT 18. NUMBER OF PAGES 19a. NAME OF RESPONSIBLE PERSON Leilani Richardson 19b. TELEPHONE NUMBER (include area code) (661) 275-5015 a. REPORT b. ABSTRACT c. THIS PAGE Unclassified Unclassified Unclassified A

MEMORANDUM FOR PRS (In-House Publication)

FROM: PROI (STINFO)

27 June 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-166**
C.T. Liu (PRSM), "Investigating the Constraint Effect in a Particulate Composite Material"
(viewgraphs)

ASME Pressure Vessel Technology Meeting
(Vancouver, Canada, 7-9 August 2002) (Deadline: 30 July 2002)

(Statement A)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.

Comments: _____

Signature _____ Date _____

2. This request has been reviewed by the Public Affairs Office for: a.) appropriateness for public release and/or b) possible higher headquarters review.

Comments: _____

Signature _____ Date _____

3. This request has been reviewed by the STINFO for: a.) changes if approved as amended, b) appropriateness of references, if applicable; and c.) format and completion of meeting clearance form if required

Comments: _____

Signature _____ Date _____

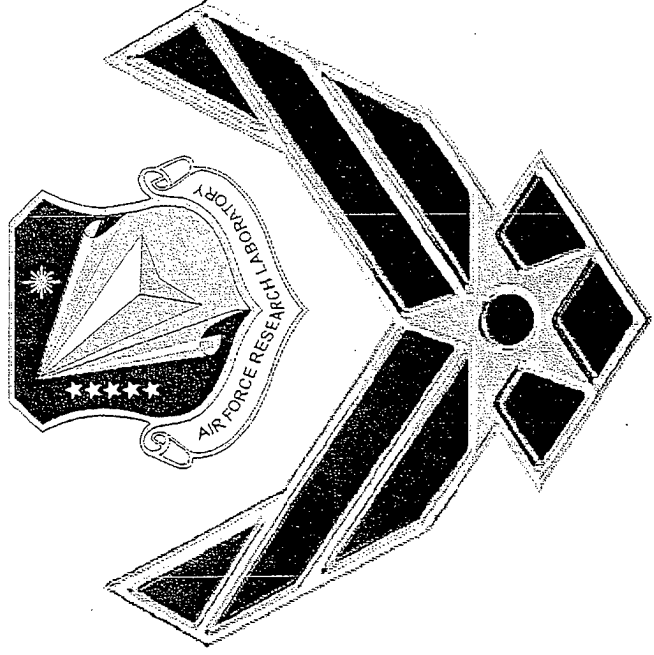
4. This request has been reviewed by PR for: a.) technical accuracy, b.) appropriateness for audience, c.) appropriateness of distribution statement, d.) technical sensitivity and economic sensitivity, e.) military/national critical technology, and f.) data rights and patentability

Comments: _____

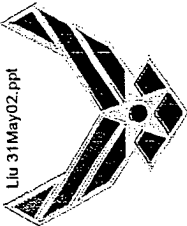
APPROVED/APPROVED AS AMENDED/DISAPPROVED

PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

Investigating the Constraint Effect in a Particulate Composite Material



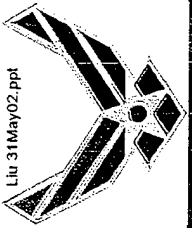
C. T. Liu
AFRL/PRSM
10 E. Saturn Blvd.
Edwards AFB CA U.S. A.
93524-7680,



Objectives



- Investigate the Constraint Effect on the Critical Stress Intensity Factor, K_{II} , for the Onset of Crack Growth in a Particulate Composite Material
 - Specimen Thickness: 0.2 in., 0.5 in., 1.0 in., 1.5 in.
- Initial Crack Length: 0.2 in., 0.3 in., 0.4 in.

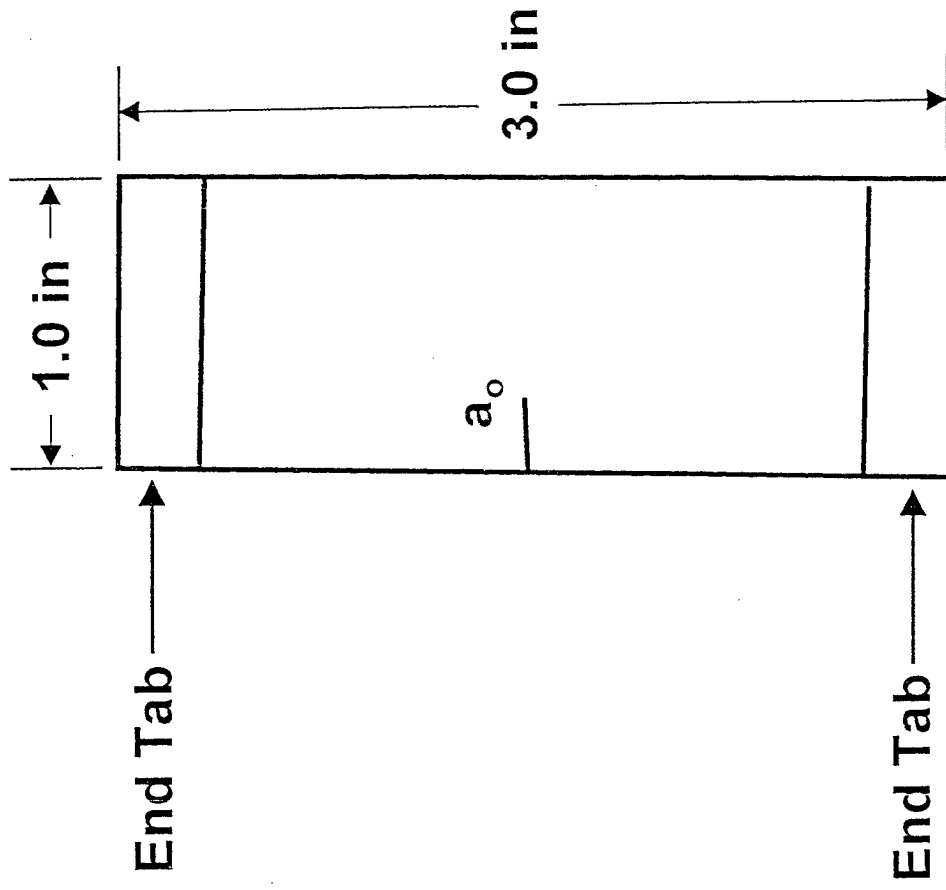


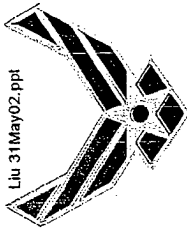
Conclusions



- Experimental findings indicate that, on the first approximation, K_{II} is independent of specimen thickness and initial crack length for the cases considered in this study.
- Due to the development of damage at the crack tip, the constraint is minimized at the crack tip and the Poisson's effect is negligible.
- For the particulate composite material under investigation, the plane-strain fracture toughness does not exist

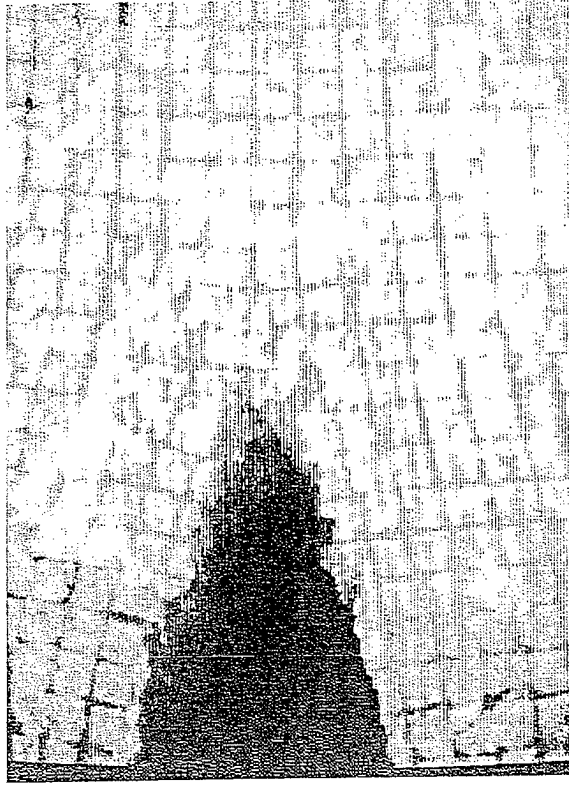
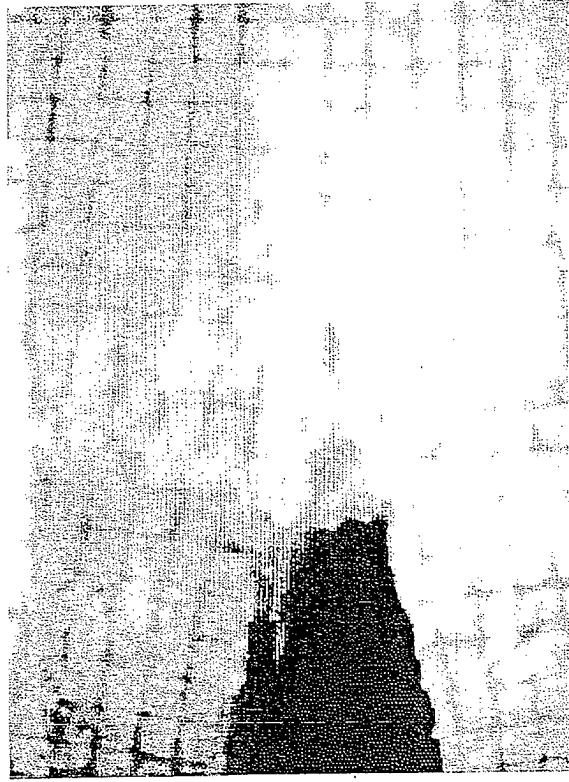
Specimen Geometry

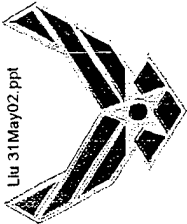




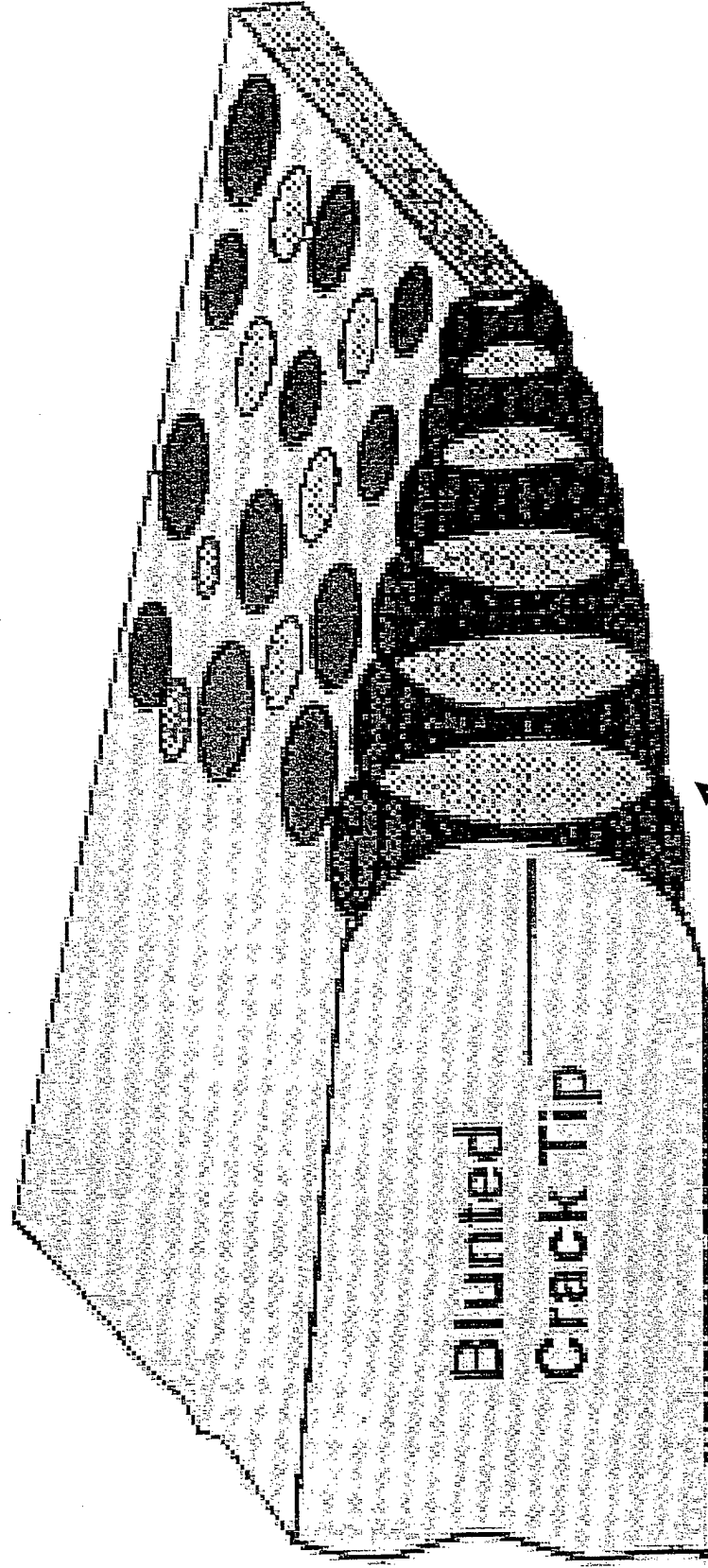
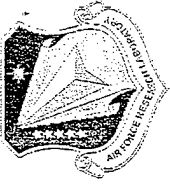
Crack Tip Profiles

(crosshead speed = 0.508 mm/min)





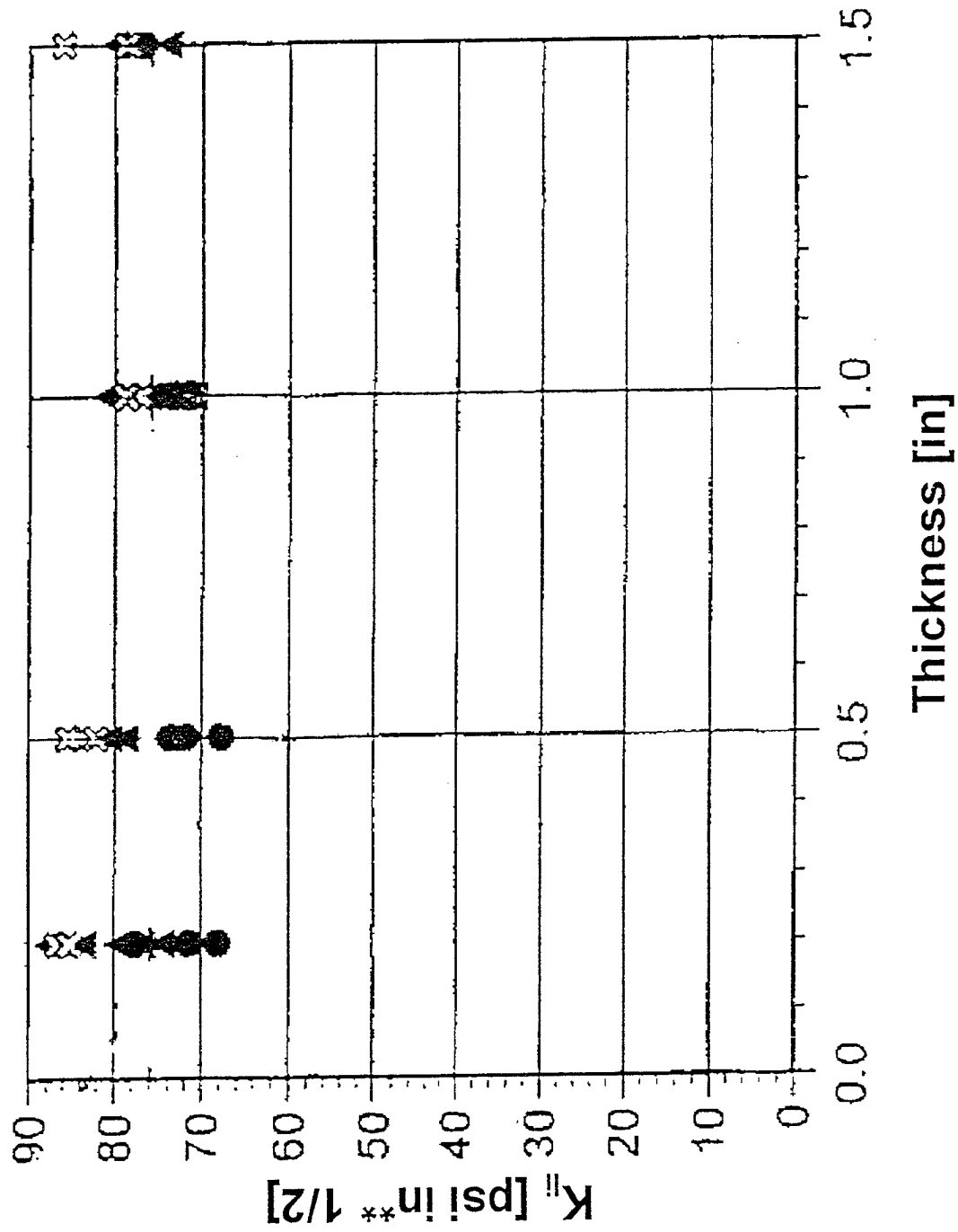
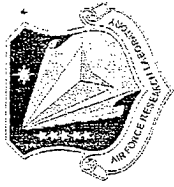
Crack Tip Damage Model

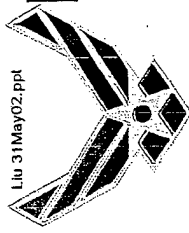


Highly Damaged Zone

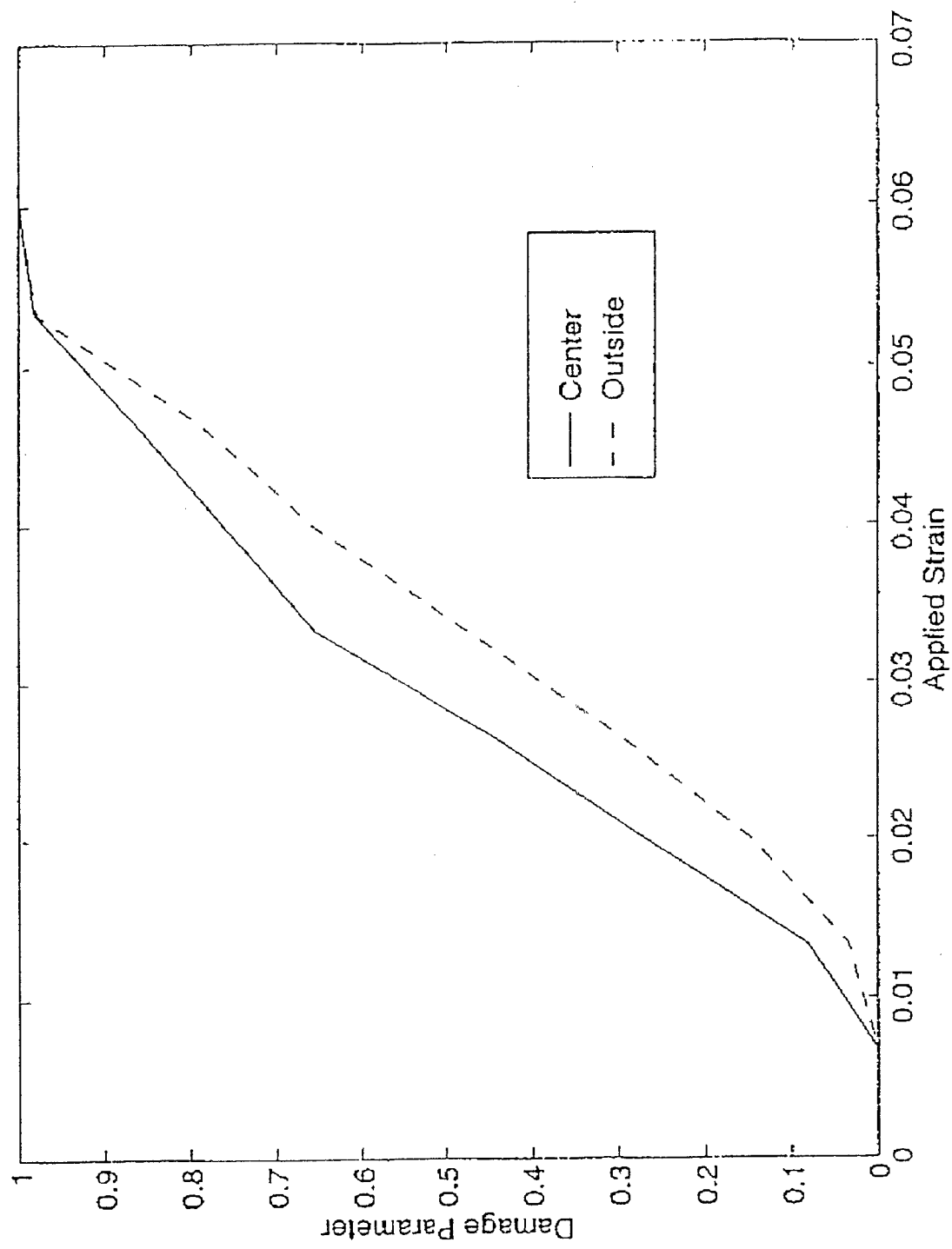
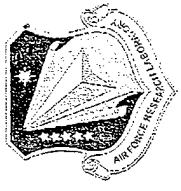


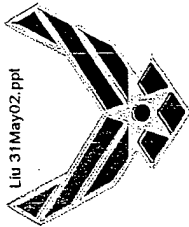
Mode I Stress Intensity Factor vs. Specimen Thickness. (Ambient Pressure)



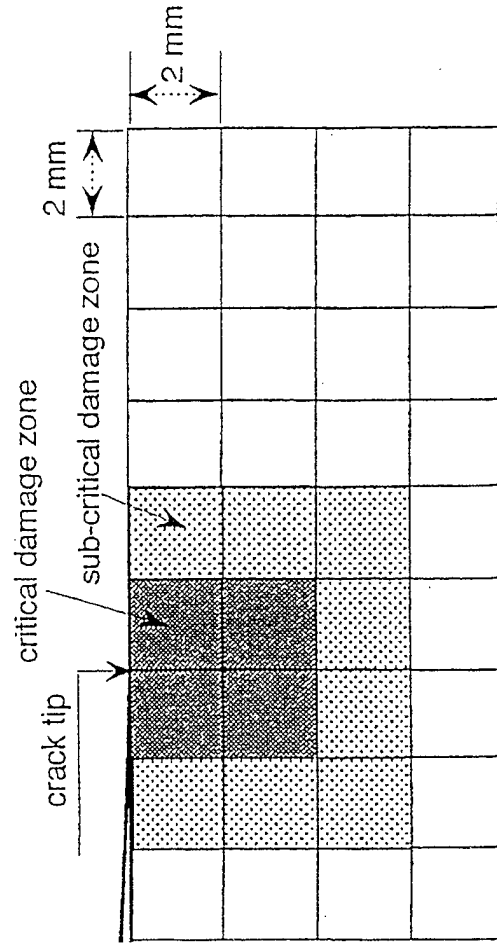
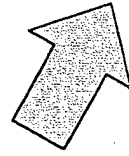
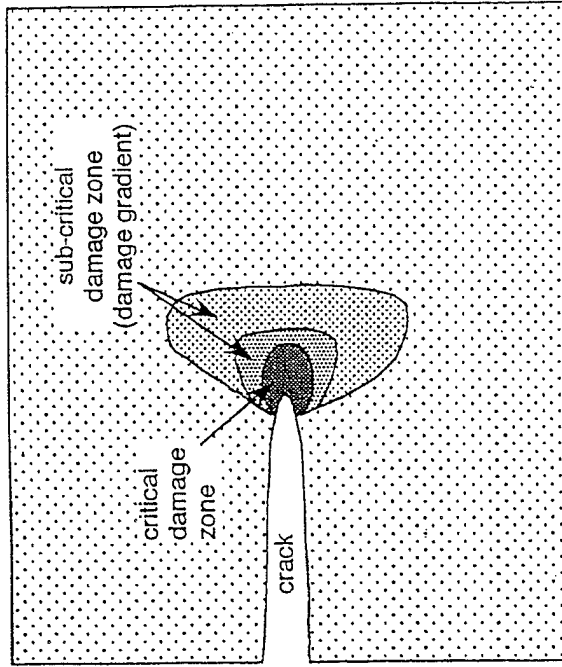
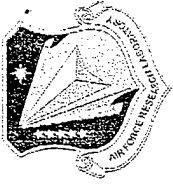


Damage Distribution near the Center and the Surface of the Specimen

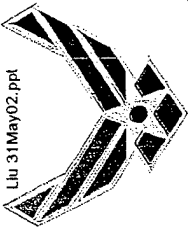




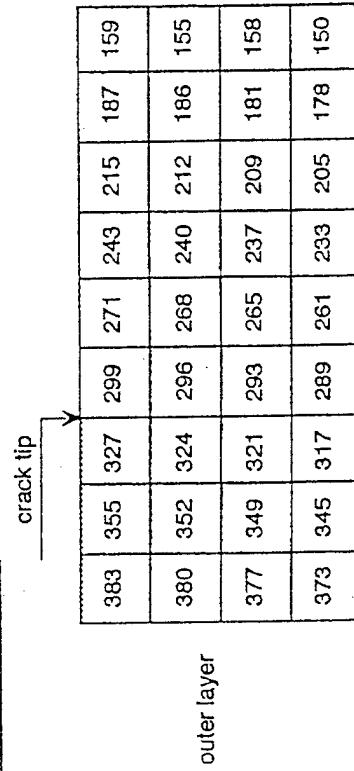
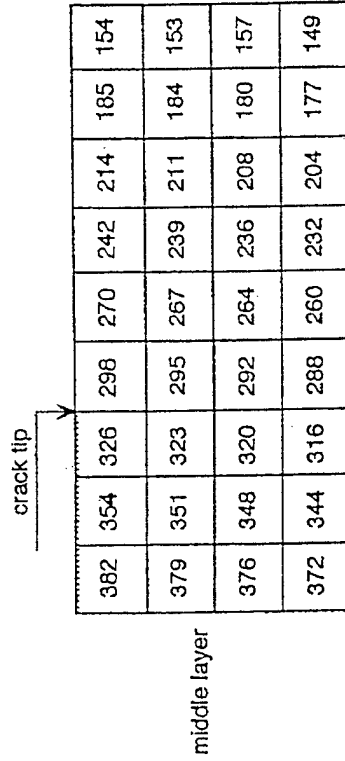
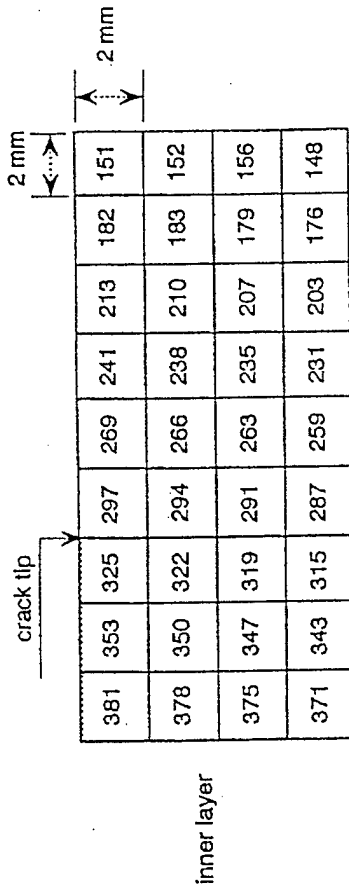
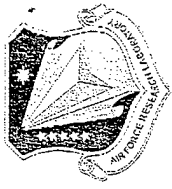
Finite Element Model

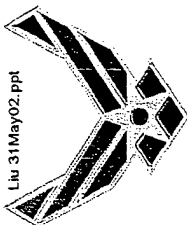


FEM mesh at crack tip



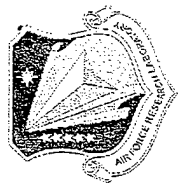
Finite Element Models of the Three Layers of the Analyzed Specimen





Liu 31 May02.ppt

Summary of Crack-damage Interaction Analysis

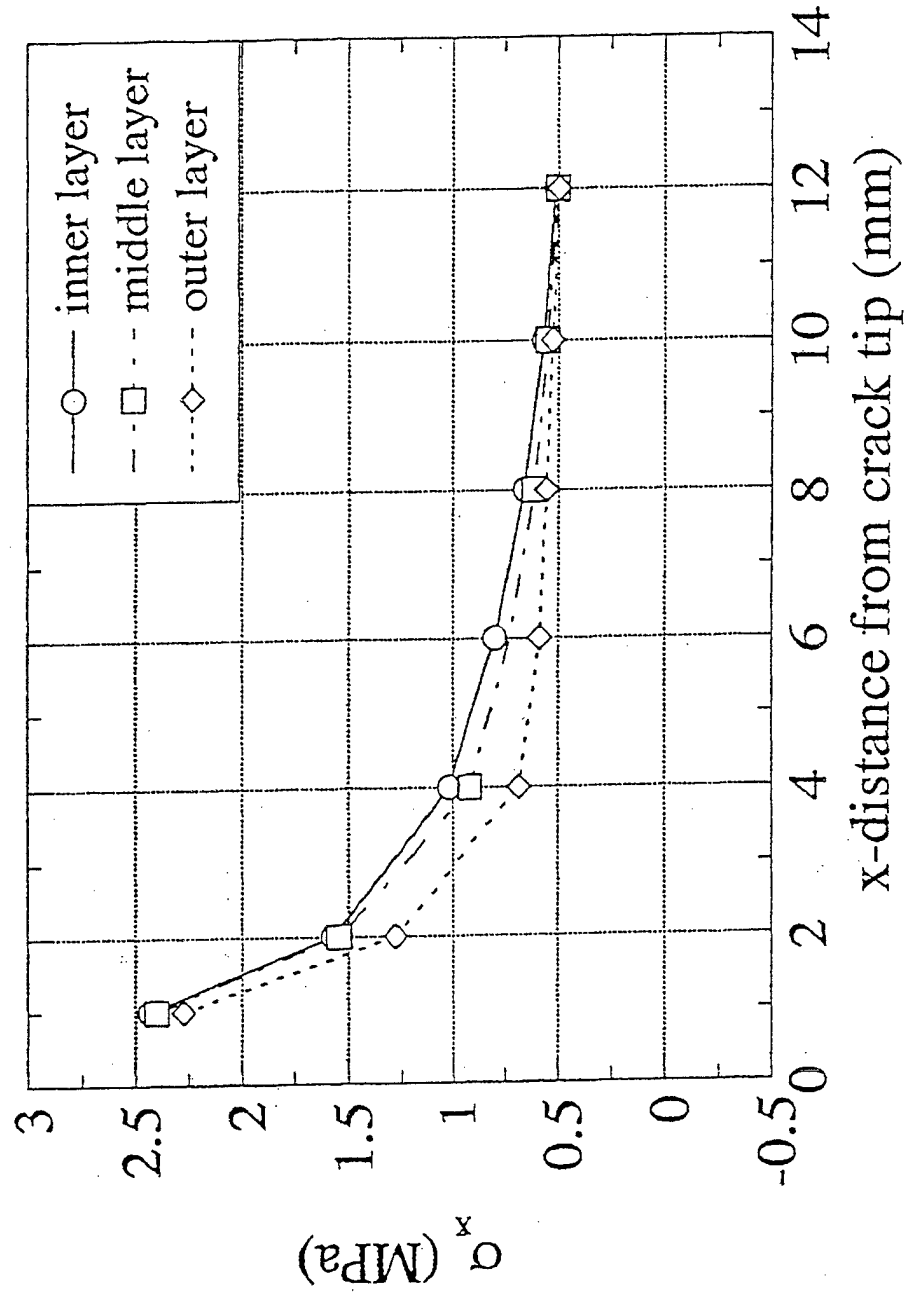


case	damage element	damage element modulus MPa (psi)	Poisson's ratio	inside layer K_I MPa-cm ^{0.5}	middle layer K_I MPa-cm ^{0.5}	outside layer K_I MPa-cm ^{0.5}
thin*	none	0.414 (60)	0.4999	1.871	-	-
1	none	-	0.4999	1.931	1.903	1.802
2	325, 297	0.414 (60)	0.4999	0.422	2.246	1.871
3	325, 297 326, 298	0.414 (60)	0.4999	0.535	0.440	2.208
4	325, 297 326, 298 327, 299	0.414 (60)	0.4999	0.573	0.524	0.455
5	325, 297, 322, 294	0.414 (60)	0.4999	0.392	2.285	1.906
6	325, 297, 322, 294 326, 298, 323, 295 327, 299, 324, 296	0.414 (60)	0.4999	0.522	0.497	0.432
7	325, 297, 322, 294 326, 298, 323, 295 327, 299, 324, 296 353, 350, 347, 319 291, 263, 266, 269 354, 351, 349, 320 292, 264, 267, 270 355, 352, 349, 321 293, 265, 268, 271	0.414 (60) 0.828 (120)	0.4999 0.4999	0.546	0.514	0.442
8	325, 297, 322, 294 326, 298, 323, 295 327, 299, 324, 296	0.414 (60)	0.1	0.336	0.339	0.342

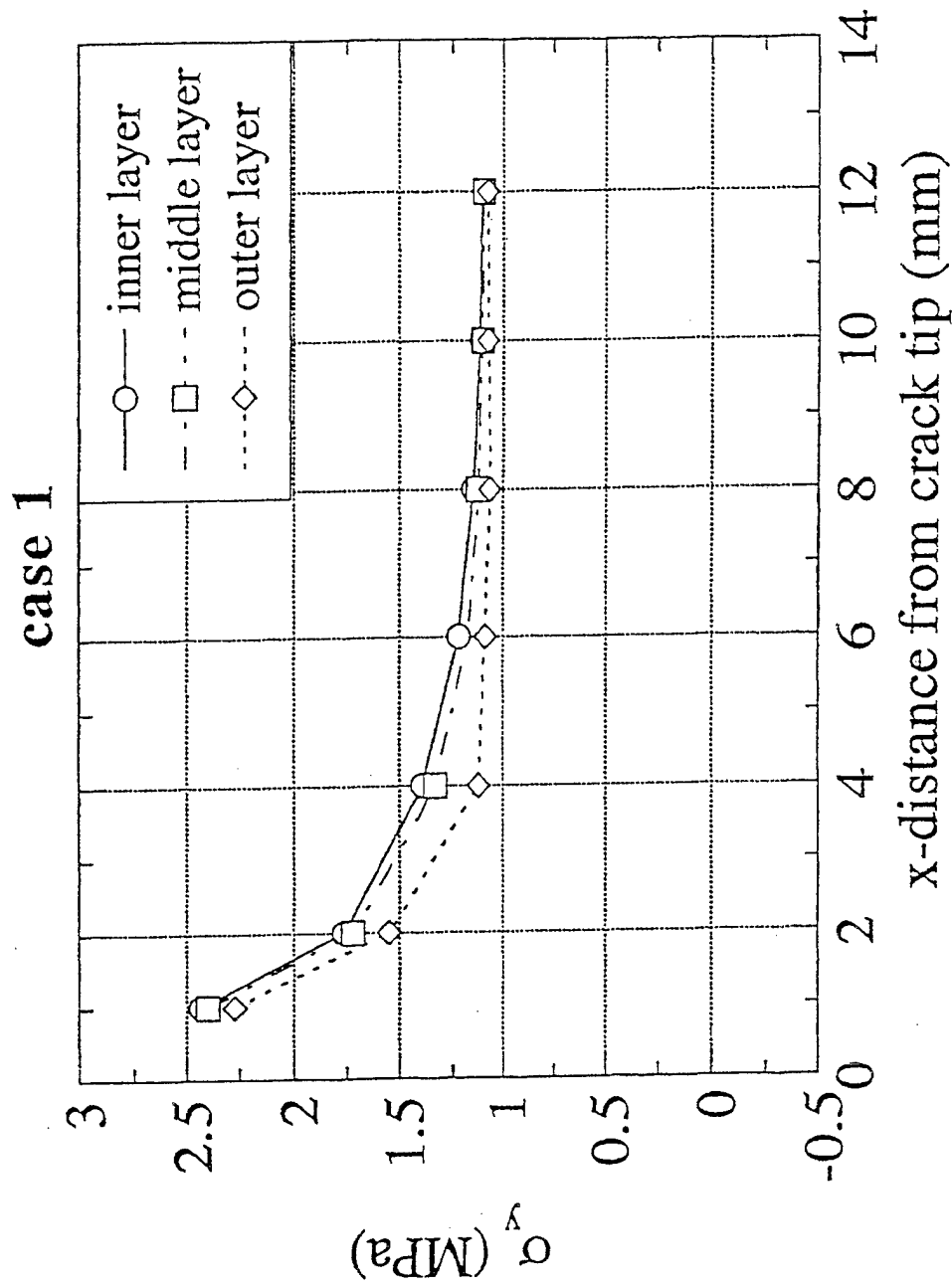
* thin specimen, specimen thickness = 0.508 cm.

Stress Distributions in the Horizontal Direction

case 1



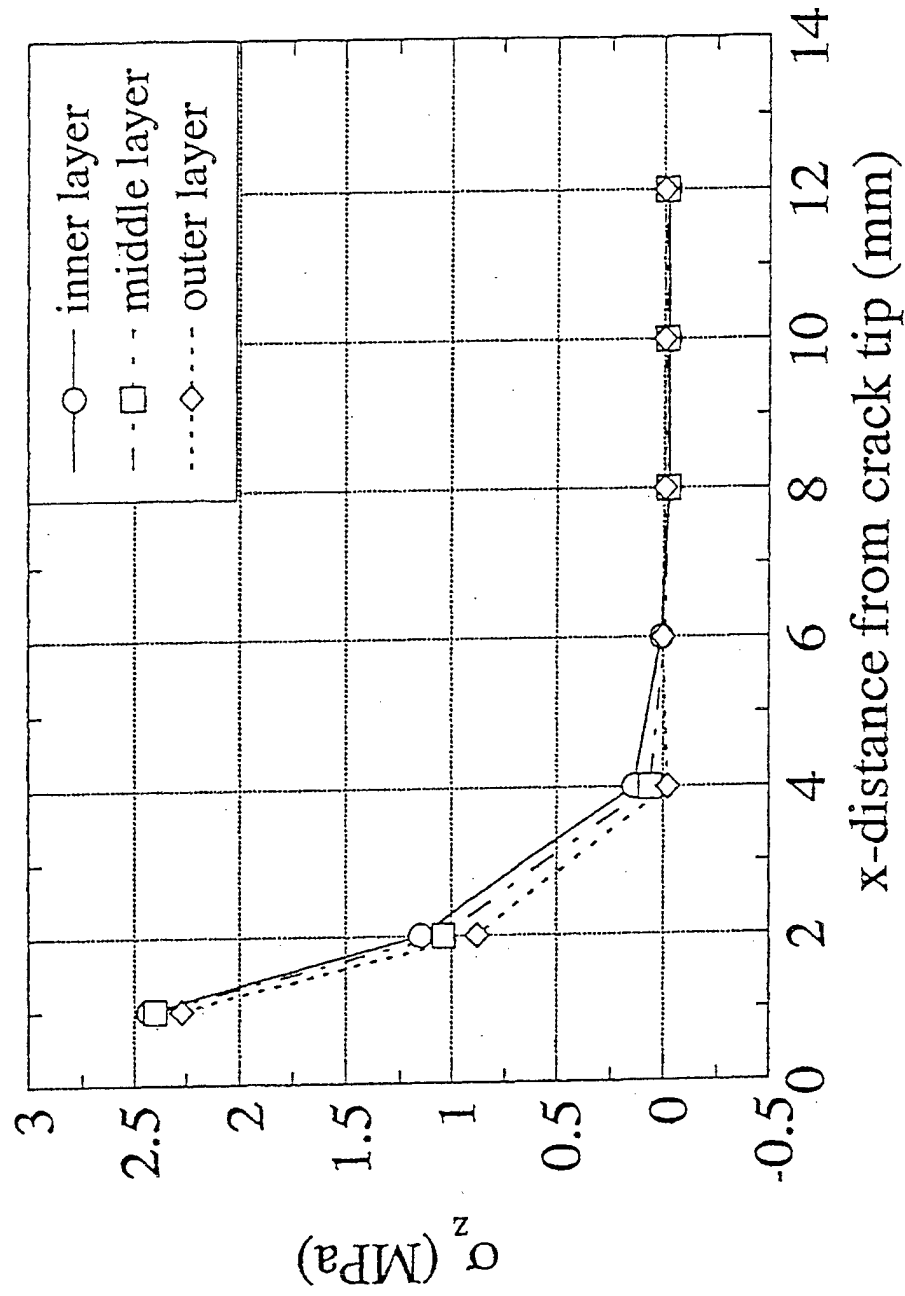
Stress Distributions in the Vertical Direction



Stress Distributions in the Thickness Direction



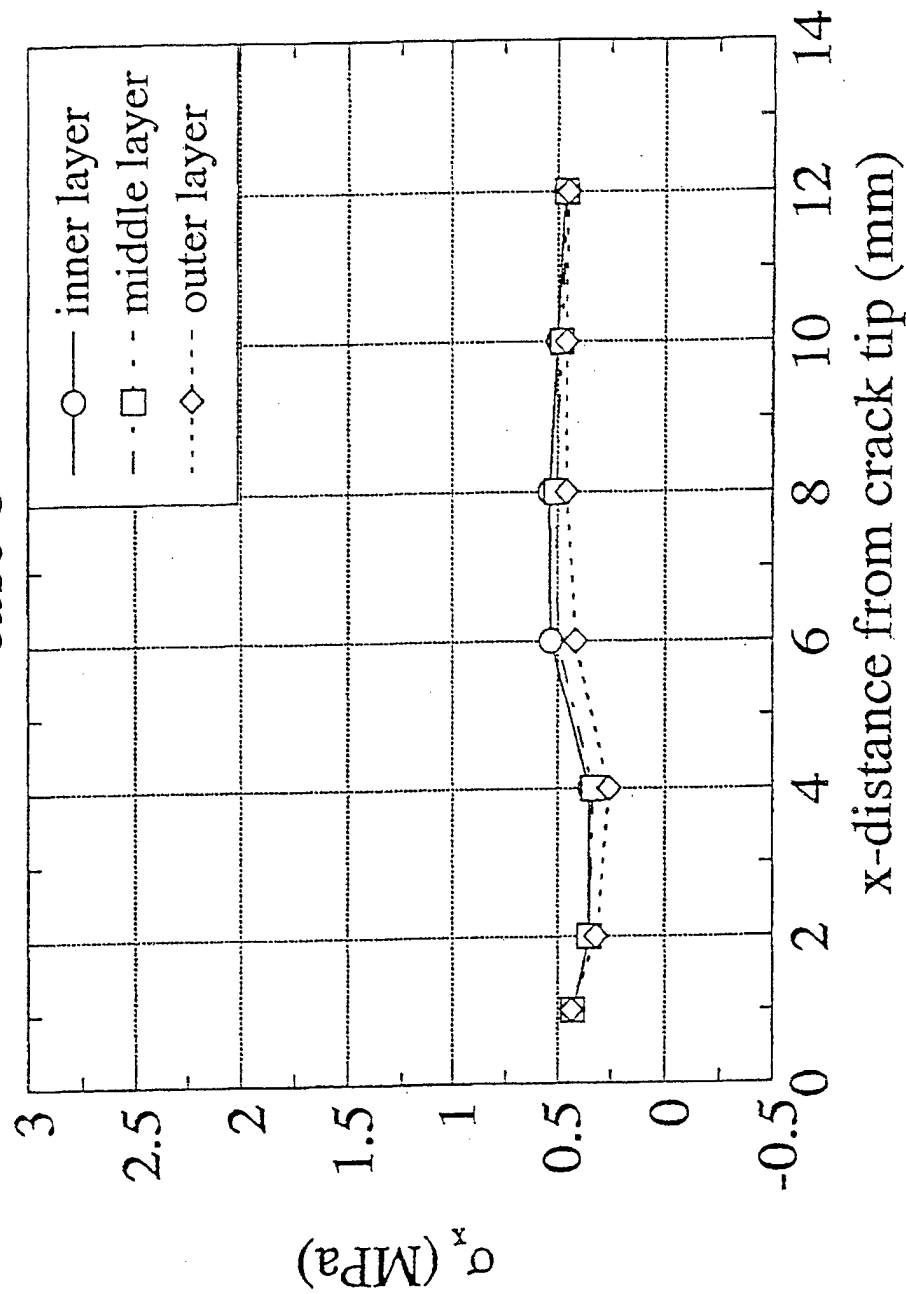
case 1

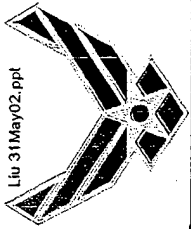


Stress Distributions in the Horizontal Direction



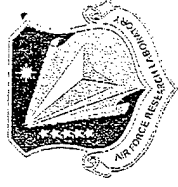
case 8



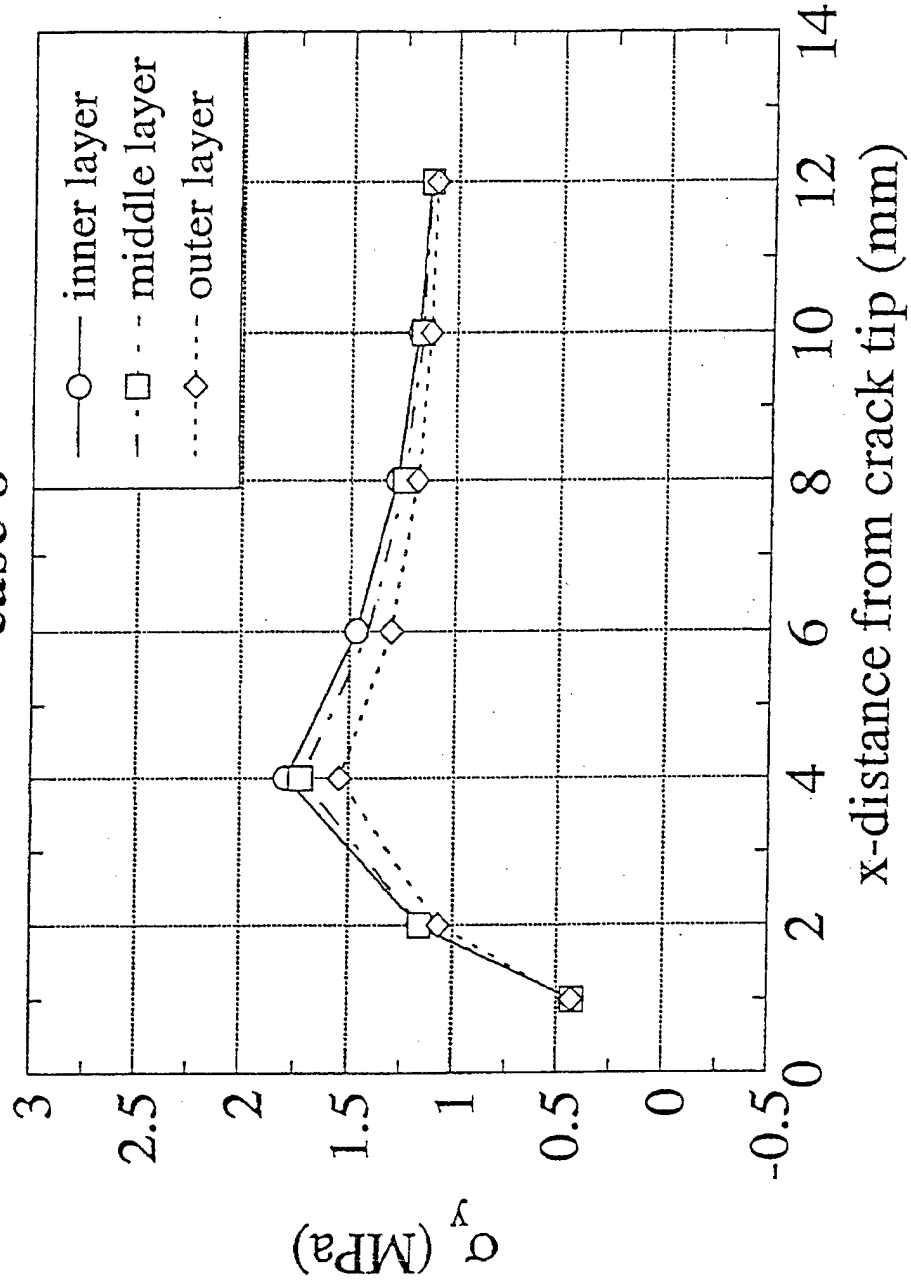


Liu 31May02.ppt

Stress Distributions in the Vertical Direction



case 8





Stress Distributions in the Thickness Direction

